

Mass Spectrometers in Space!

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Exploration of our solar system over several decades has benefitted greatly from the sensitive chemical analyses offered by spaceflight mass spectrometers. When dealing with an unknown environment, the broadband detection capabilities of mass analyzers have proven extremely valuable in determining the composition and thereby the basic nature of space environments, including the outer reaches of Earth's atmosphere, interplanetary space, the Moon, and the planets and their satellites. Numerous mass analyzer types, including quadrupole, monopole, sector, ion trap, and time-of-flight have been incorporated in flight instruments and delivered robotically to a variety of planetary environments. All such instruments went through a rigorous process of application-specific development, often including significant miniaturization, testing, and qualification for the space environment. Upcoming missions to Mars and opportunities for missions to Venus, Europa, Saturn, Titan, asteroids, and comets provide new challenges for flight mass spectrometers that push to state of the art in fundamental analytical technique. The Sample Analysis at Mars (SAM) investigation on the recently-launch Mars Science Laboratory (MSL) rover mission incorporates a quadrupole analyzer to support direct evolved gas as well as gas chromatograph-based analysis of martian rocks and atmosphere, seeking signs of a past or present habitable environment. A next-generation linear ion trap mass spectrometer, using both electron impact and laser ionization, is being incorporated into the Mars Organic Molecule Analyzer (MOMA) instrument, which will be flown to Mars in 2018. These and other mass spectrometers and mission concepts at various stages of development will be described.